AECOM

Periodic Bathymetry Survey Report

Fall 2011 Post Hurricane Irene Survey

December 2014

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Prepared for:

Cooperating Parties Group

Newark, New Jersey

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Periodic Bathymetry Survey, Fall 2011 Post Hurricane Irene Survey Report

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1.0 Overview

The Fall 2011 Post Hurricane Irene Bathymetry Survey (Fall 2011 Survey) was performed under the specifications of the United States Environmental Protection Agency (USEPA)-approved Quality Assurance Project Plan (QAPP) for Lower Passaic River Restoration Project: Periodic Bathymetric Surveys, Revision 2 (AECOM, 2010) as modified by Field Modification Number FM-110921 for the performance of a bathymetry survey of lower 14 miles of the Lower Passaic River (LPR) after Hurricane Irene. This survey is the fourth in a series of periodic multibeam bathymetry surveys performed by the Cooperating Parties Group (CPG) as part of the Lower Passaic River Remedial Investigation (RI) and Feasibility Study (FS). Gahagan & Bryant Associates, Inc. (GBA) conducted three previous multibeam surveys in 2007, 2008, and 2010 over the same extent of the Lower Passaic River Study Area (LPRSA) and one survey in the River Mile (RM) 10.9 Study Area in the summer of 2011. The previous surveys are documented in the following submittals:

1. Single Beam Hydrographic Survey of Passaic River: River Mile 0.5 to 8.2 and Wallington Avenue Bridge to Upstream Limit (GBA, 2007a)
2. Passaic River Multibeam Hydrographic Survey: River Mile 0 to 14.3 (GBA, 2007b)
3. Passaic River Multibeam Hydrographic Survey Newark, New Jersey December 2008 (GBA, 2009)
4. Periodic Bathymetry Survey Report: June 2010 Multibeam Survey (GBA, 2011a)
5. Bathymetry Survey Report for Lower Passaic River RM 10.9 Characterization, July 2011 (GBA, 2011b).

The Fall 2011 survey was performed by GBA between October 5, 2011 and November 10, 2011, with mobilization to the LPRSA and checking of control points on October 4, 2011. The survey was suspended on October 6, 2011 due to damage incurred by the survey equipment and restarted on October 23, 2011 once the equipment was repaired. The survey (Figure 1) was conducted in the RM 0 to 14 area of the LPRSA. AECOM performed oversight on behalf of the CPG during the fall 2011 survey and reviewed the report submittal. Sea Engineering, Inc. provided oversight on behalf of the USEPA.

The Fall 2011 Survey was performed by the CPG at the direction of USEPA to characterize the potential effects of a large storm event on the LPRSA. The passage of Hurricane Irene on August 27-28, 2011, provided a unique opportunity to characterize the potential effects of a large storm event on LPRSA. River flows following Hurricane Irene were the highest since October 1903, at 20,800 cubic feet per second (cfs) recorded at the United States Geological Survey (USGS) Little Falls gauging station (concurrent flows at Dundee Dam were 26,000 cfs), exceeding the previous recent high flow events of March 2010 (15,800 cfs) and March 2011 (16,200 cfs). Water levels peaked at approximately 14 feet (exceeding flood stage by approximately 7 feet) and rose initially due to storm surge and remained elevated for several days due to freshwater runoff. The Fall 2011 Survey provides data on surficial sediment conditions for comparison with those observed during previous (2007, 2008, 2010, and summer 2011) multibeam bathymetry surveys to support characterization of changes, if any, which may have occurred during the high flow event.

All work was performed per the QAPP, contract requirements, United States Army Corps of Engineers (USACE) specifications, and acceptable industry standards. The precision and accuracy of the data collected were consistent with the USACE manual, Engineering and Design - Hydrographic Surveying (EM 1110-2-1003; USACE, 2002). The raw and processed data have been reviewed to ensure that

the requirements of the USEPA-approved QAPP have been met. The data collected during this survey meet the data quality objectives to address the above study questions, with consideration to the uncertainty inherent in these data and described in the QAPP.

No interpretations of the survey results are included in this report and its attachments. Data analysis and interpretation of this survey as well as its relationship to other surveys will be conducted as part of the LPRSA Conceptual Site Model (CSM) development, sediment stability analyses, Lower Passaic River/Newark Bay Modeling Program, and other components of the LPRSA RI/FS.

The following documents are attached:

1. Fall 2011 Post Hurricane Irene Bathymetry Survey Report, Lower Passaic River, New Jersey prepared by GBA
2. Periodic Bathymetry Survey, Fall 2011 Post Hurricane Irene Survey Oversight Report, Lower Passaic River, New Jersey, prepared by AECOM.

Figure 1 Survey Limits

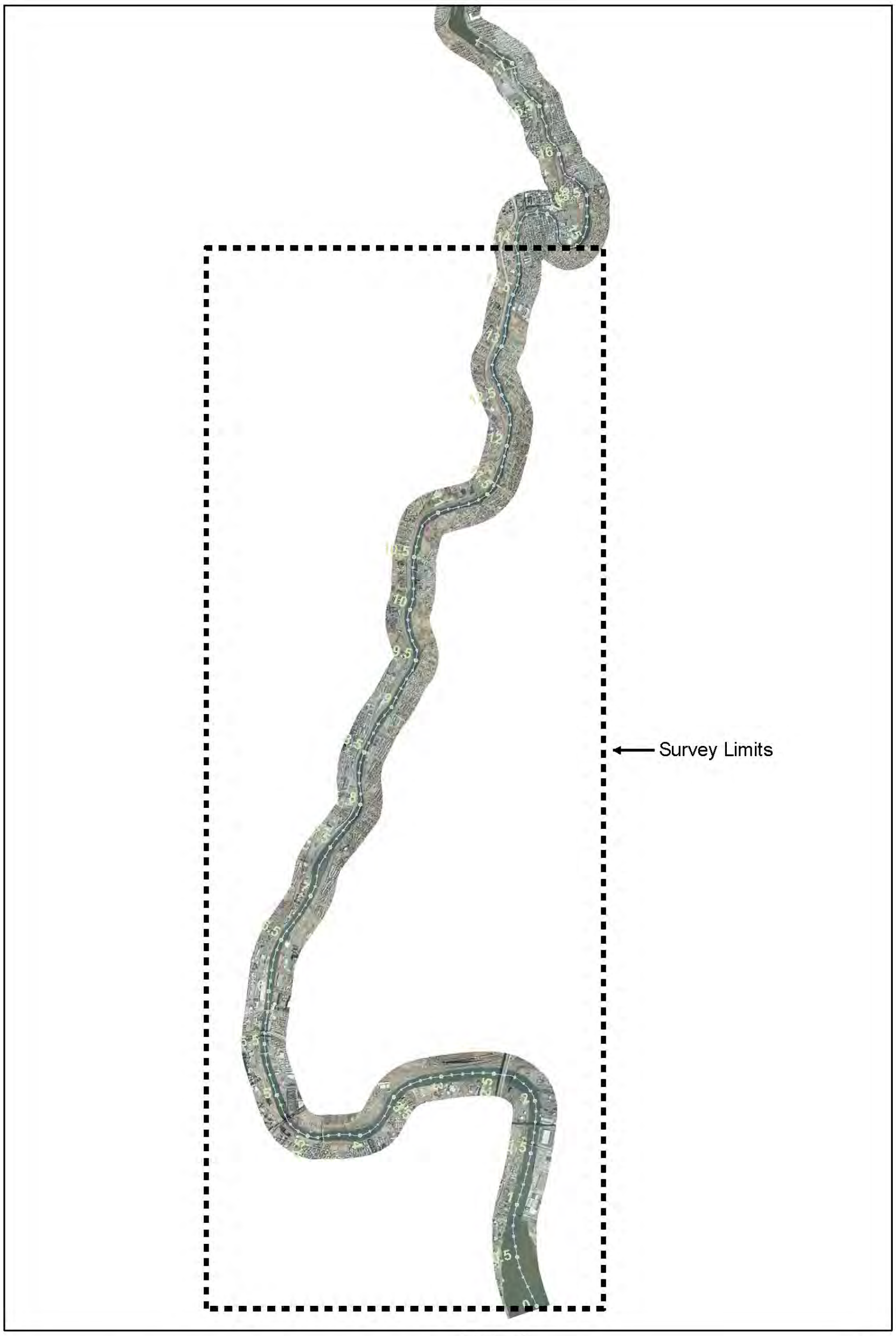

Figure 1
Periodic Bathymetric Survey
Lower Passaic River Restoration Project
Multi-beam Survey Limits

AECOM

2.0 References

AECOM, 2010. Quality Assurance Project Plan, Lower Passaic River Restoration Project: Periodic Bathymetric Surveys, Revision 2, May.

Gahagan & Bryant Associates (GBA), 2007a. Single Beam Hydrographic Survey of Passaic River: River Mile 0.5 to 8.2 and Wallington Avenue Bridge to Upstream Limit. August 2007. November.

GBA, 2007b. Passaic River Multibeam Hydrographic Survey: River Mile 0 to 14.3.

GBA, 2009. Passaic River Multibeam Hydrographic Survey Newark, New Jersey December 2008. February.

GBA, 2011a. Periodic Bathymetry Survey Report: June 2010 Multibeam Survey. April.

GBA, 2011b. Bathymetry Survey Report for Lower Passaic River RM 10.9 Characterization, July 2011. November.

United States Army Corps of Engineers (USACE), 2002. Engineering and Design Manual - Hydrographic Surveying. EM 1110-2-1003. Washington, D.C. Last accessed in December 2011 at: http://140.194.76.129/publications/eng-manuals/em1110-2-1003/toc.htm.

Attachment 1

Fall 2011 Post Hurricane Irene Bathymetry Survey Report, Gahagan & Bryant Associates, Inc. (GBA)

FALL 2011 POST HURRICANE IRENE BATHYMETRY SURVEY REPORT

Lower Passaic River

New Jersey

Submitted:
December 2011
Revised:
December 2014

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APPENDICES

1.0 INTRODUCTION

Gahagan & Bryant Associates, Inc. (GBA) has performed four previous bathymetry surveys of the Passaic River between September 2007 and July 2011, three encompassed the lower 14 river miles of the river and one was focused on the River Mile (RM) 10.9 area. The passage of Hurricane Irene on August 27-28, 2011, provided a unique opportunity to characterize the potential effects of a large storm event on the Lower Passaic Study Area (LPRSA). River flows following Hurricane Irene were the highest since October 1903, at 20,800 cubic feet per second (cfs) recorded at the United States Geological Survey (USGS) Little Falls gauging station (concurrent flows at Dundee Dam were 26,000 cfs), exceeding the previous recent high flow events of March 2010 (15,800 cfs) and March 2011 (16,200 cfs). Water levels peaked at approximately 14 feet (exceeding flood stage by approximately seven feet) and rose initially due to storm surge and remained elevated for several days due to freshwater runoff. Following this event, a multibeam survey was conducted of the lower 14 river miles of the Passaic River for comparison with previous bathymetry surveys to support characterization of changes, if any, which may have occurred during the high flow event. In addition, consistent with previous periodic bathymetry surveys in 2008 and 2010, a single beam survey was conducted for thirteen selected transects. These surveys were performed with the same methodologies as all previous surveys.

The GBA survey team departed for the Passaic River on October 4, 2011. Multibeam patch testing and quality assurance/quality control (QA/QC) testing were initiated on October 5, 2011. Survey lines were established based upon channel coordinates to best obtain 100% bottom coverage. The bathymetry surveys commenced on October 5, 2011 and concluded on November 10, 2011. The purpose of this report is to summarize the operations and quality controls employed during the survey and subsequent data processing. Control information is provided in Appendix 1. Results from the survey are presented in Appendices 2 and 3. Appendix 4 contains the field notes and Appendix 5 includes supporting data such as the AutoCAD drawings, HYPACK files, field notes, and ASCII data.

2.0 SURVEY SETUP AND CONTROL

On October 4, 2011, GBA survey technicians recovered various control points along both sides of the Passaic River that had been used during previous surveys. Reference marks to determine water surface elevation with tide staffs were set at PATH 3, Nutley and the Cooperating Parties Group (CPG) dock. These were used to provide daily (QA/QC) checks of the accuracy of the Real Time Kinematic (RTK) Global Positioning System(s) derived water surface elevations during the survey. An additional tide staff was set at PORT 1.

Listed hereafter are the National Geodetic Survey (NGS) control monuments used in this survey. The values shown are North American Datum of 1983 (NAD 83)

(horizontal) and North American Vertical Datum of 1988 (NAVD 88) (vertical).

NGS PID	NAME	LATITUDE	LONGITUDE	ELEVATION	H/V
AI7796	01392590 A	N 40°43'58.61588"	W 074°09'13.73144	11.67'	H/V
KV3414	G101	N 40°47'49.60797"	W 074°08'17.21832"	14.24'	H/V

The project control NAD 83 and NAVD 88 values and descriptions are listed as follows:

NAME	NORTHING	EASTING	ELEVATION (NAVD 88)	DESCRIPTION
01392590 A	692097.663	588059.003	11.670'	AI7796 Steel Rod
G101	715490.263	592312.818	14.240'	KV3414 Disk
PORT 1	695188.398	597847.469	8.961'	Sheared Metal Bolt
PATH	701845.995	585643.039	5.705'	PSE&G Disk "PRO4"
NUTLEY 2	720714.538	592028.699	7.952'	TPS NEAR NUTLEY
CPG2	733825.441	597109.293	7.936'	TPS NEAR CPG

Tide staffs were established via closed level runs from the static Global Positioning System (GPS) control points. The NGS VERTCON program was utilized in adjusting the NAVD 88 vertical values to National Geodetic Vertical Datum of 1929 (NGVD 29) datum. The tide staffs and values are listed as follows:

STAFF	NAVD 88 ELEV	NGVD 29 ELEV	DESCRIPTION
PORT 2	8.89'	10.01'	Mark on southeast corner of concrete
PATH 3	6.11'	7.19'	Triangle cut on concrete wall on east side of river
NUTLEY	8.73'	9.77'	Mark on concrete wall on west side of river
CPG	8.18'	9.19'	Triangle cut on top of steel bulkhead

3.0 BATHYMETRY SURVEY

All work conducted during the bathymetry survey was performed in accordance with the Quality Assurance Project Plan (QAPP) for Lower Passaic River Restoration Project: Periodic Bathymetric Surveys, Revision 2 (AECOM, 2010), contract requirements, USACE specifications, and acceptable industry standards. The following represent minor deviations from the QAPP (AECOM, 2010). However, these deviations did not compromise the data quality objectives developed for this survey, which were met.

1. October 6, 2011 – An area approximately 120 feet by 550 feet was not surveyed because of obstructions related to the Phase 1 Removal Action at the Lister Avenue Site.
2. October 27, 2011 – There were several areas along the shore where GBA was not able to achieve the (-) 6-foot contour because of trees overhanging the river, and large rocks along the shoreline. Construction around the

Route 3 bridge located at RM 11.6 reduced coverage compared to historical surveys as well.

3. October 31, 2011 through November 4, 2011 – High tides peaked at lower levels during this week ([+] 4 feet NGVD29 as opposed to [+] 6 feet NGVD29 during the prior week). The lower high tides along with overhanging trees limited access to complete the (-) 6-foot contour.

Multibeam Survey

GBA performed a multibeam survey that extended from the mouth of the Passaic River at RM 0.0 to RM 14, which is the upriver limit of effective multibeam coverage. The multibeam survey covered the main channel prism and all depths greater than (-) 6.0 feet NGVD, residing within the confines of the riverbanks. GBA's survey maintained a buffer of approximately 75 feet around all bridges and in-water structures, as specified in the QAPP. GBA planned and conducted the survey lines and data collection to ensure 100% bottom coverage. GBA used the multibeam survey data collected within the confines of the primary 90 degree cone (nadir to 45 degrees both port and starboard) for the processing of final survey results and deliverables. The 90 degree beam angle was selected based upon criteria outlined within the USACE's Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003 (USACE, 2002) and GBA's experience in the multibeam environment. Beams residing within the confines of the 90 degree beam angle utilize amplitude detection, which is preferred to phase detection in the outer beams. Sufficient data were collected to clearly define 0.5 foot contour intervals. GBA met all requirements outlined within the USACE's Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003 (USACE, 2002) as augmented by April 1, 2004 updates to Chapter 11 for multibeam surveying. GBA met standards for multibeam surveys conducted for Navigation and Dredging Support Surveys in soft bottom materials.

Single Beam Survey

GBA surveyed the thirteen selected transects as surveyed during the fall 2008 and spring 2010 survey events. These transects extended from RM 1.6 to RM 8.0 and met all requirements outlined within the USACE's Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003 (USACE, 2002).

Survey Equipment

GBA utilized equipment analogous to the equipment used on the 2007, 2008, and 2010 surveys. The Fall 2011 survey equipment included the following components:

Multibeam Equipment

1. The Multibeam data collection system consisted of a Reson 8101 SeaBat system operating at +/- 240 kilohertz (kHz), with a total beam angle of 210 degrees. Each individual beam angle measures 1.5 degrees X 1.5 degrees. The 8101 was upgraded to include Reson's backscatter and side scan

software options. The Reson's 8101 transmitter and receiver (transducer) is permanently mounted on a bow-deployable arm, designed by GBA to best suit the shallow draft requirement of this project plus ensure the stability of the transducer

2. Primary horizontal and vertical positioning was accomplished by utilizing a Leica SmartGPS GX1230+ rover/receiver with a CDMA cellular phone modem. RTK corrections were obtained via the CDMA modem from a permanent CORS (Continuously Operating Reference System) site located at the New Jersey Institute of Technology (NJIT) in Newark, NJ. See Appendix 1 for specifics on the NJIT site and Station Description for NJI2, which is the NGS control point utilized for the NJIT CORS site. This method of positioning was chosen in lieu of establishing our own transmitting base stations at numerous control points due to security issues. GBA also utilized the aforementioned positioning methods, as it replicated the 2007, 2008, and 2010 surveys. The NJIT CORS Station and the Leica SmartGPS GX1230+ were used for all horizontal and vertical positioning, and included water surface elevations. These procedures have been used on all past surveys.

3. GBA utilized the most recent version of HYPACK/HYSWEEP (2010) for data collection and editing which collects and processes all data on high speed PC-based data collection platforms.

4. Inertial Positioning was accomplished by utilizing an Applanix – TSS POSMV.

5. Heave/pitch/roll/yaw compensation was accomplished with the Applanix – TSS POSMV.

6. The method for determining water surface elevations (tide levels) was the same methodology used on all previous surveys. Analog tide staffs, used as QA/QC for the RTK, were set at the same tidal gauging locations used for the 2007, 2008, and 2010 surveys. Real time tides were obtained by using GPS in the RTK mode and these RTK elevations were checked and verified and compared to the analog tide staffs numerous times during the course of a survey day to ensure the accuracy required, as specified in the QAPP, was met or exceeded.

7. The survey vessel *Sea Fix*, a 25-foot aluminum hulled vessel constructed by Thomas Marine in 1997, was used for the bathymetry survey work. It was powered by twin 175 horsepower (HP) outboard motors with an onboard power generating system to operate the survey equipment. Both the single and multibeam surveys in the Fall 2011 Post Hurricane Irene Bathymetry Survey were conducted from the GBA survey vessel *Sea Fix*. The vessel captain was the same on all three multibeam surveys and Ed DeAngelo has served as the Technical Project Manager on all multibeam surveys conducted on the project plus the single beam surveys in 2008, 2010, and 2011.

Single Beam Equipment

1. GBA utilized an Odom Mark II operating at 200/33 kHz (+/- 10 %) with a 3.5 degree beam angle transducer.

2. The GPS positioning equipment were the same as item 2 above for multibeam positioning.

3. Data collection system and software were identical to the systems identified in item 3 above.

4. Water surface/tide elevations were obtained utilizing the same methods described in item 6 above.

5. The survey vessel, *Sea Fix*, as described in item 7 above, was used to conduct the single beam surveys using the same captain.

4.0 DATA PROCESSING AND COLLECTION

GBA made all efforts to ensure that the multibeam data collected provided 100% bottom coverage. This was the case the majority of the time, but shallow water depths were the limiting factor on some of the survey lines and 100% overlap was not possible in the shallower depths, as referenced in GBA's initial proposal and subsequent conversations with AECOM staff during prior surveys.

The initial processing of the multibeam data was performed on site to ensure accuracy and that sufficient coverage had been achieved. The multibeam data were then transferred to GBA's Houston Office for final processing and QA/QC verification.

The raw data were reviewed for obvious outliers and then processed through all phases with HYSWEEP software. HYPACK/HYSWEEP multibeam processing is broken into three phases. In Phase 1, raw data files are opened and the parameters for the application of ancillary data (motion, tide, speed of sound, etc.) are defined. At this stage the tide values that are applied to each raw file can be reviewed and erroneous RTK spikes removed (as under bridges). Heave, pitch, and roll are reviewed prior to application to soundings, and finally, GPS position holidays can be edited out of the database. In Phase 2 of multibeam data processing or HYSWEEP editing, ancillary sensor data are applied to the soundings and individual passes of sounding data. Sounding points can be edited manually or by automatic filters based on angle/offset from nadir, min/max depth values, and beam quality. The filters applied to the multibeam echosounder data included:

- The minimum/maximum depth, which varied with each survey pass (to eliminate soundings above and below) based on the location in the channel and the depth of that location;
- Beam angle which excluded beams 45 degrees from nadir; and
- Quality flags, meaning that each sounding is given a quality flag of 1 to 3 with 3 being the highest quality; all soundings below quality level 3 were removed.

The final phase of multibeam processing is area based. During this phase, a series of overlapping multibeam data are binned to a regularly spaced matrix. In the final phase, the overlap of adjacent sweeps is evaluated to ensure that the bottom profiles align correctly. Additional point reduction is performed to remove flyer points based on statistical analysis of the soundings in each cell of a 3-foot x 3-foot matrix. Final data point files are generated as A) all sounding points, B) average sounding for 1-foot x 1-foot matrix, and C) average sounding for a 3-foot x 3-foot matrix.

Overlapping swaths were reviewed and compared for coverage, depth repeatability, accuracy, and gaps. Field QC processes were reviewed and tide readings compared and applied to the raw data. GBA's single beam cross-section surveys were overlaid with the multibeam data to ensure accuracy of the data sets. Once the multibeam data were edited and verified, it was formulated into final products, such as contours and binned data. Contours were generated at 0.5-ft intervals and are provided in AutoCAD DWG files.

Back scatter and sidescan sonar data from the Reson 8101 were collected in Fall 2011 as had been done for the three previous surveys conducted by GBA in 2007, 2008, and 2010. Back scatter imagery can be processed into side scan type imagery, as needed, to assess current or future conditions of the river bed.

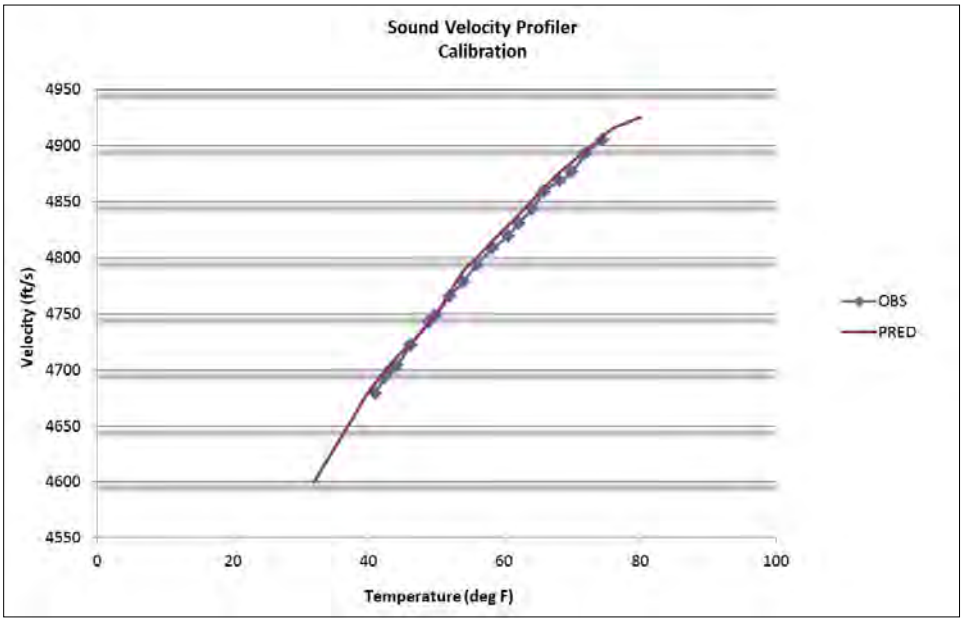
Single beam survey data were processed in a manner similar to the multibeam dataset using HYPACK editing software. Raw data files were opened and the parameters for the application of ancillary data (motion, tide, speed of sound, etc.) were defined. At this stage the tide values that are applied to each raw file can be reviewed and erroneous RTK spikes removed (as under bridges). Final single beam data points were then exported to ASCII XYZ files for the generation of contours and sounding plots.

5.0 QUALITY CONTROL/QUALITY ASSURANCE

Prior to the start of the Fall 2011 Post Hurricane Irene Bathymetry Survey, GBA performed several QA/QC procedures. In addition to physically verifying all horizontal and vertical offsets for positioning and sounding equipment the survey crew performed a complete systems operation check in Baltimore Harbor prior to mobilization to New Jersey.

Sound Velocity Profiles

The sound velocity profiler calibration was verified as per the method proscribed in the USACE's Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003 (USACE, 2002). The profiler was set in a distilled-water bath using ice to vary the water temperature. Observed sound velocity measurements and water temperature were recorded and plotted against a predicted curve.



Throughout each survey day, GBA surveyors performed several velocity casts and applied them to the multibeam data to ensure that tidal variation did not significantly affect the sounding data.

RTK Corrections

To ensure the accuracy and precision of the Leica SmartNet RTK corrections that were received from the NJIT CORS station, GBA (using a back pack rover) made RTK point observations at both NGS monuments and GBA control points. All checks were within tolerances for RTK GPS of +/- 0.05 ft.

Daily checks of the RTK position system were performed by logging the vessel position at the dock at the beginning and end of each day to ensure no horizontal changes. RTK tides were checked three times (the beginning, middle, and end of each day) by comparing the computed RTK tides to analog tide readings at Nutley and/or the CPG dock. All RTK tides checks agreed with analog readings within tolerances for RTK GPS of +/- 0.1 ft.

Patch Tests

Patch tests were used to determine and correct system bias for pitch, roll, and yaw. These tests were performed on four occasions during the course of the Fall 2011 Post Hurricane Irene Bathymetry Survey as follows.

1. October 5, 2011 – Initiation of the survey (Pre-Survey)
2. October 23, 2011 – Remobilization following repairs to multibeam mount (Re-Start of Survey)
3. November 5, 2011 – Mid-survey test as specified in the QAPP (Mid-Survey)
4. November 10, 2011 – Completion of the survey (Post-Survey)

All patch tests were performed in Upper Newark Bay where there was sufficient water depth in the maintained channels for the roll bias test, and sufficient bottom elevation change/slope to perform the pitch, yaw, and latency tests. In 2011, the patch and performance testing was moved to the Upper Newark Bay, within the confluence of the Passaic and Hackensack Rivers and immediately north of the railway bridge. Prior patch and performance tests had been conducted in the Lower Newark Bay, but ongoing maintenance and new dredging work in the Lower Newark Bay affected the area.

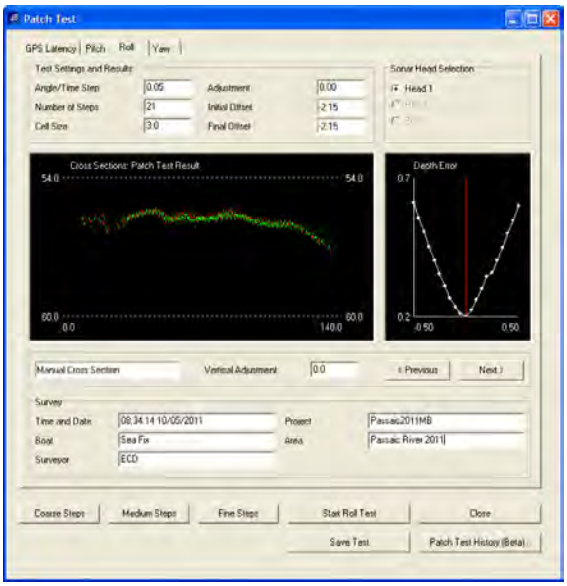
Because the values for each bias are completely dependent on hardware installation, and will vary from vessel to vessel, there are no Corps of Engineers' standards. However, the Corps of Engineers does recommend that the roll bias is measured to the nearest tenth of a degree (0.1), and pitch and yaw are measured to the nearest degree.

Patch Test Results Summary

Date	Latency (Seconds)	Roll (Degrees)	Pitch (Degrees)	Yaw (Degrees)
October 5, 2011	0	-2.15	0.20	-2.30
Multibeam Mount Repaired				
October 23, 2011	0	-1.80	2.20	-0.80
November 5, 2011	0	-1.80	2.20	-0.80
November 10, 2011	0	-1.85	2.20	-0.80

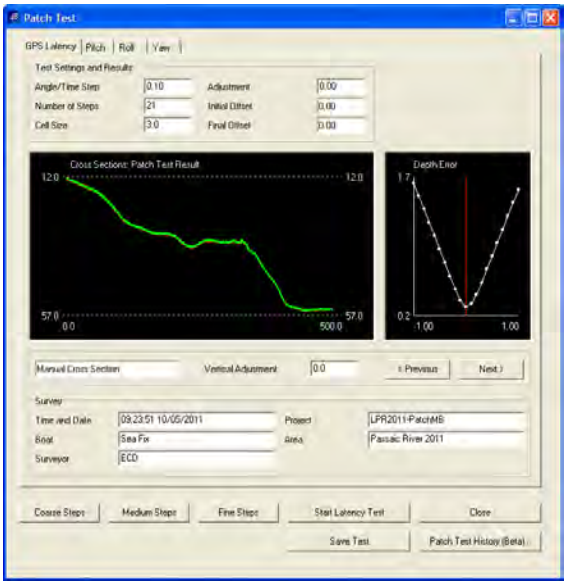
Screen captures of the results from the HYPACK analysis for each bias variable follow below.

Results from the **October 5, 2011** Pre-Survey Patch Test in Newark Bay

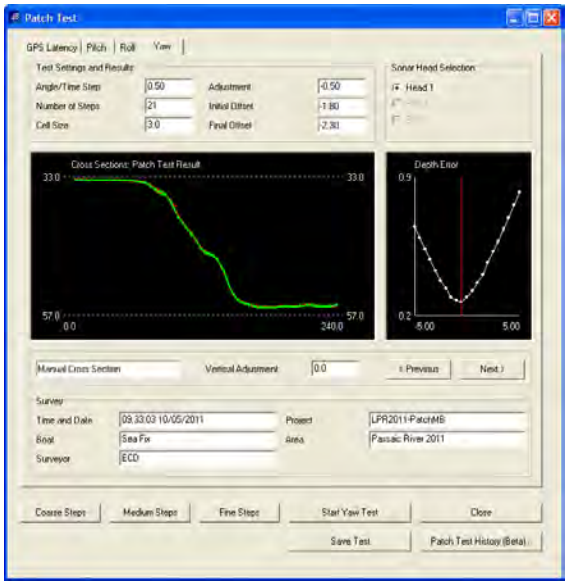


Roll

Pitch



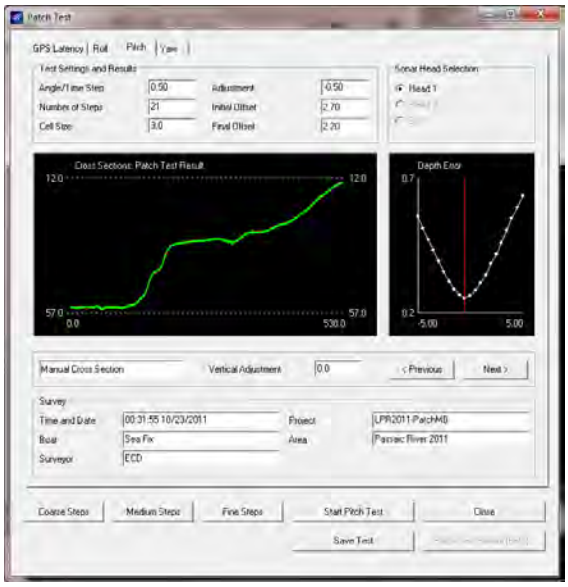
Latency



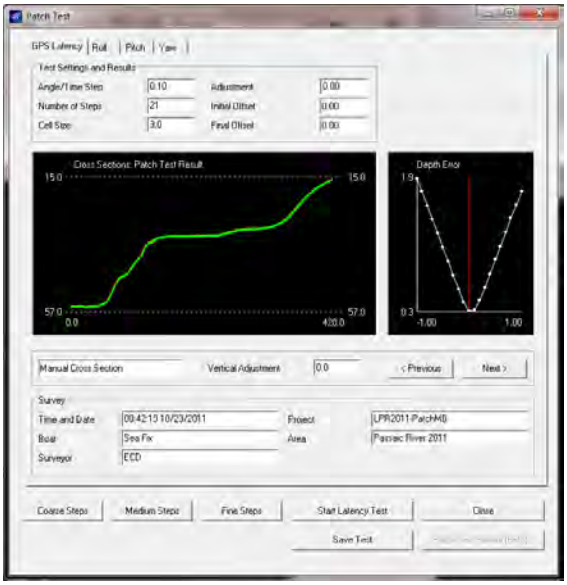
Yaw

Results from the **October 23, 2011** Re-Start of Survey Patch Test in Newark Bay

Roll



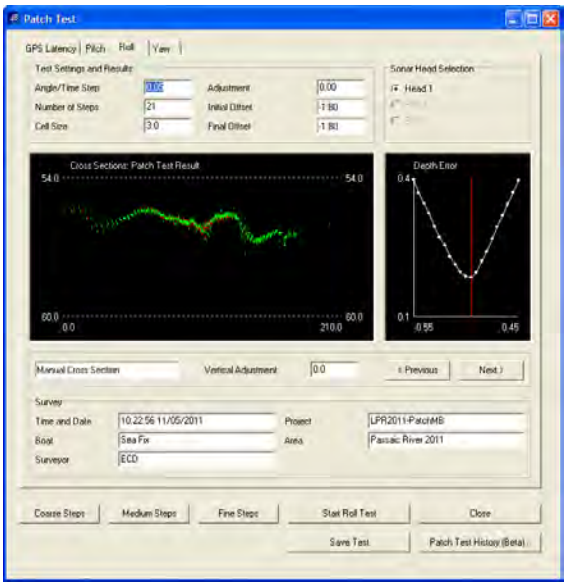
Pitch



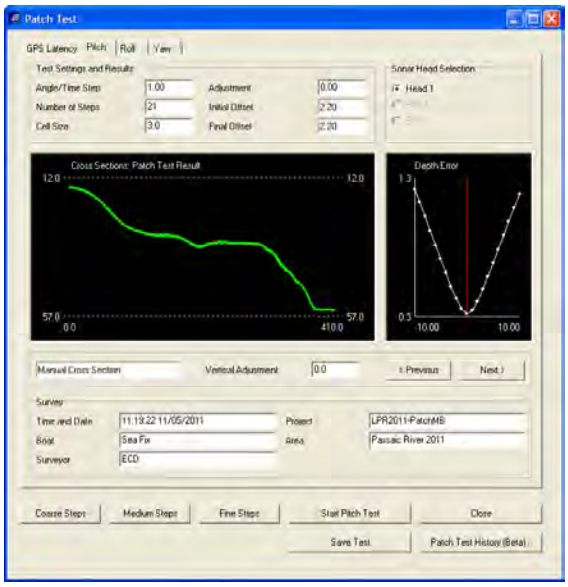
Latency

Yaw

Results from the **November 5, 2011** Mid-Survey Patch Test in Newark Bay



Roll



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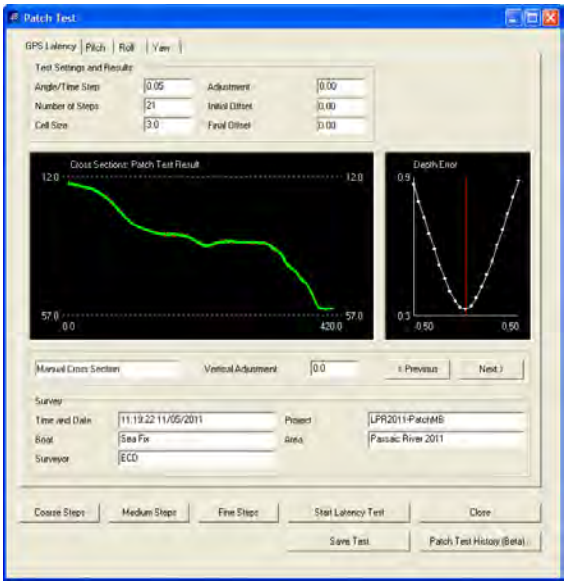

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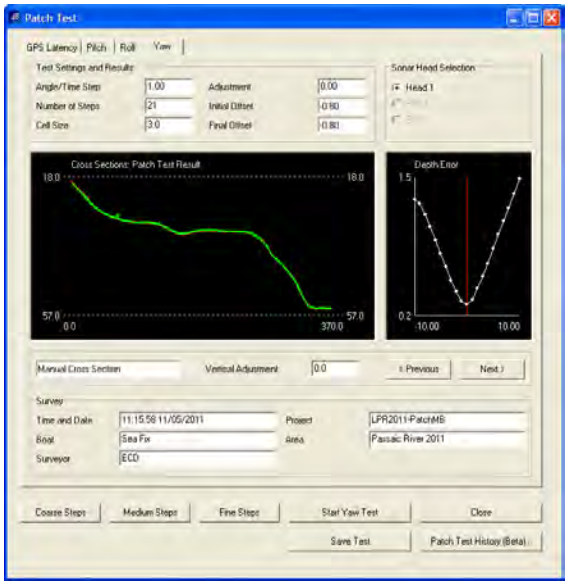
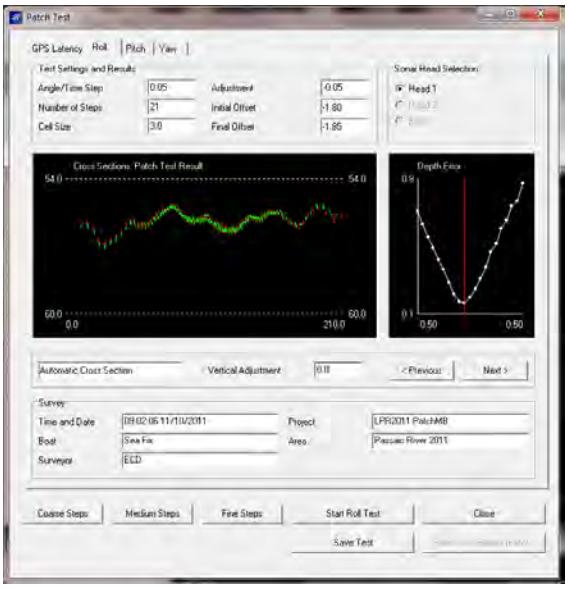
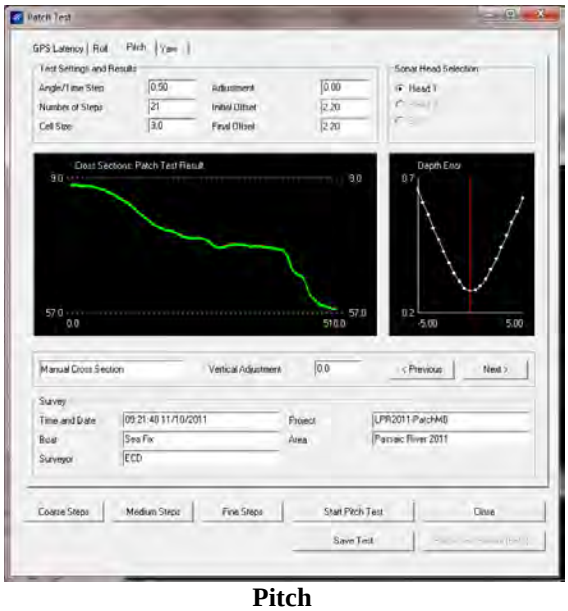


Yaw

Results from the **November 10, 2011** Post-Survey Patch Test in Newark Bay



Roll



Pitch

Latency

Yaw

Performance Tests

The multi-beam performance test consists of two parts: 1) beam angle test and 2) single beam test. The beam angle test compares multibeam check lines to a reference surface and estimates the depth accuracy of the multibeam system at various angle limits. The estimated accuracy can be used to determine if the multibeam system meets survey specifications. Similarly, the single beam test provides a statistical comparison of single beam cross-sections to a reference multibeam surface.

The reference surfaces were different for each performance test but were all collected in the same location in Upper Newark Bay. As per the prior surveys of the Lower Passaic River, the same reference surface was used during a given patch and performance test, but varied between patch and performance tests performed during the survey. This practice has been conducted consistently since the 2008 Lower Passaic River survey.

Four performance tests were performed to document the accuracy of the bathymetry survey system. Tests were done concurrent with the Patch Tests noted on pages 9-12 and occurred prior to survey operations on October 5, 2011 (Pre-Survey), upon remobilization to the site on October 23, 2011 (Re-Start of Survey), at approximately the mid-point of the survey on November 5, 2011 (Mid-Survey), and at the completion of the survey on November 10, 2011 (Post-Survey).

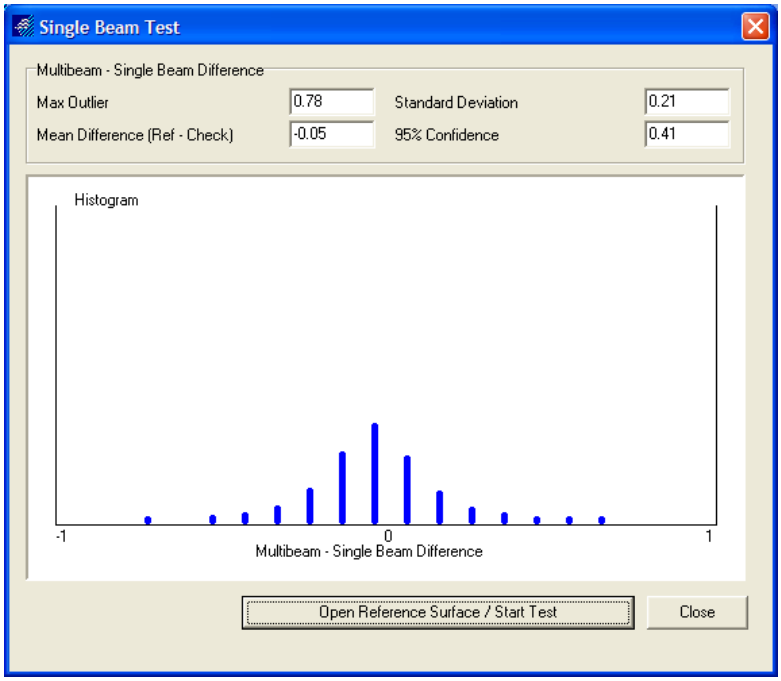
The reference area for each performance test contained the same number of target lines (10 lines). However during the data collection for the reference surface, artifacts were created by boat wake, or loss of the RTK corrections due to cellular dropout. When that occurred, the lines were re-run to be used in the test analyses. The number of lines referred to in the comment includes those that were rerun.

The repeatable results of all the performance tests show that survey system remained stable in its accuracy and precision through the course of the survey operations. The recommended Corps of Engineers' criteria for multibeam performance tests in soft bottom material are: 1) maximum allowable mean bias (mean bias) <0.2 feet; 2) maximum outlier of 1 foot; and a standard deviation at 95% confidence not to exceed +/- 2.0 feet.

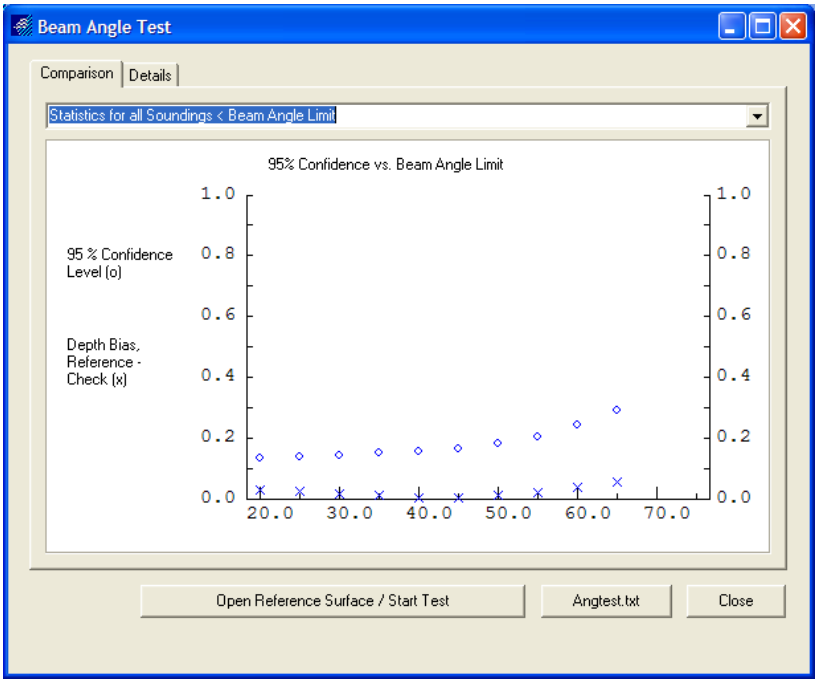
Results from the four performance tests are presented below:

October 5, 2011 Pre-Survey Performance Tests

Single beam-Multibeam Performance Test

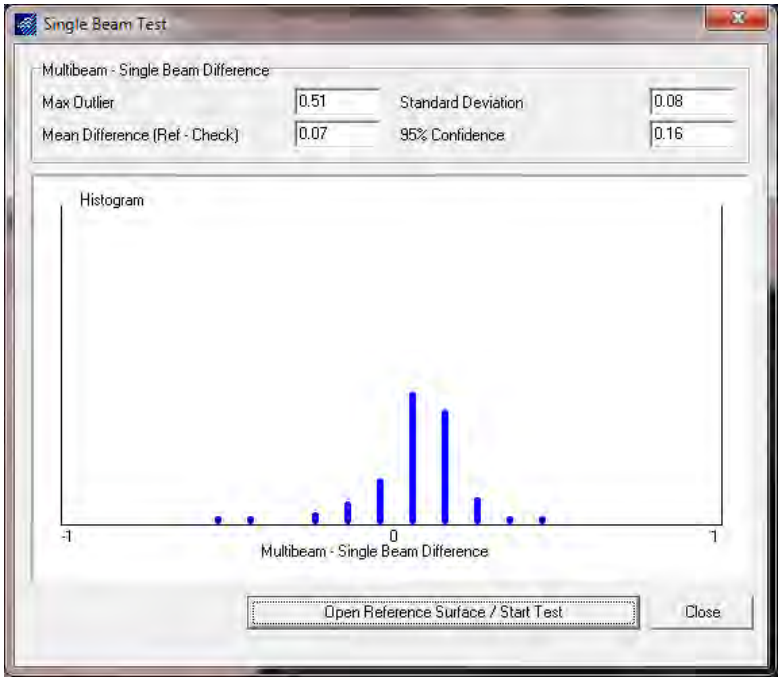


Beam Angle

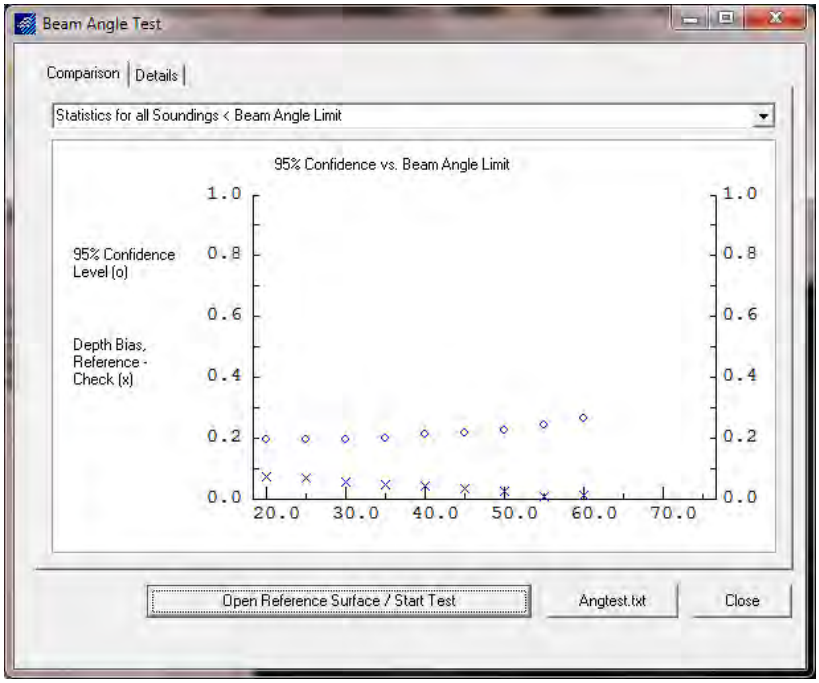


October 23, 2011 Re-Start of Survey Performance Tests

Single beam-Multibeam Performance Test

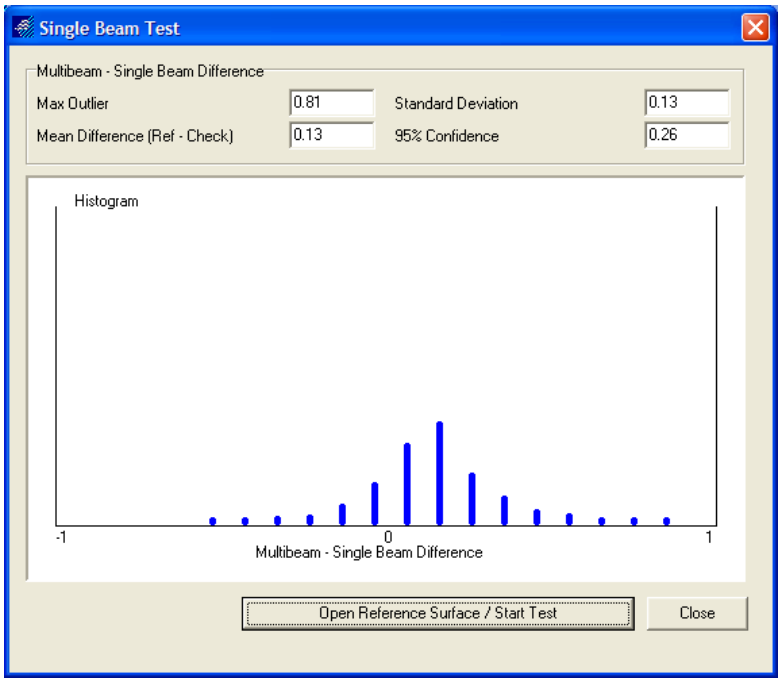


Beam Angle

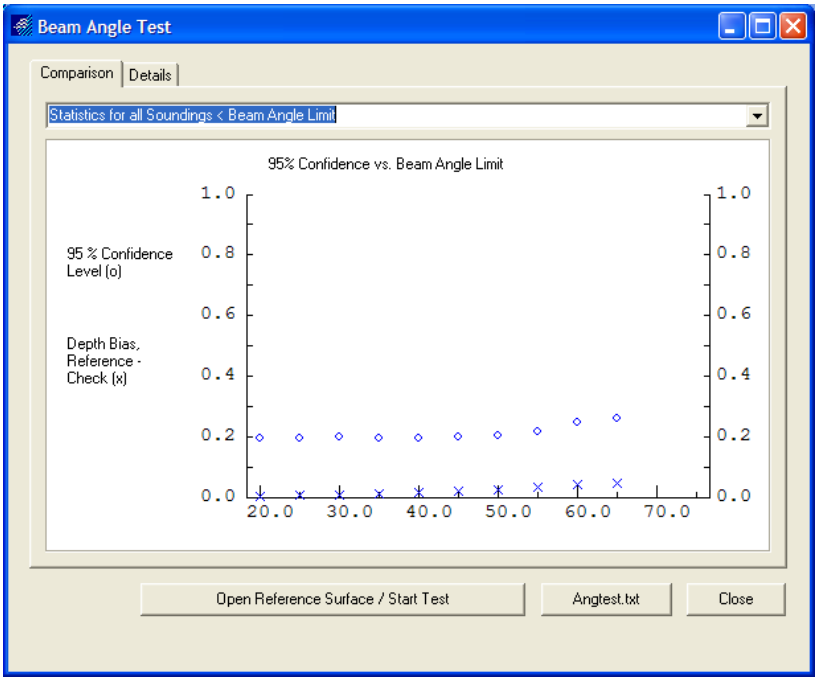


November 5, 2011 Mid-Survey Performance Tests

Single beam-Multibeam Performance Test

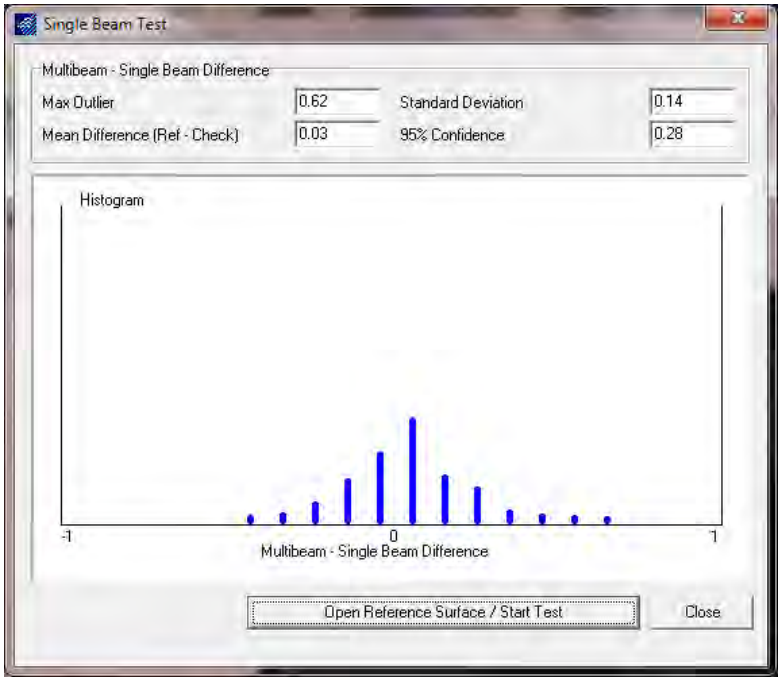


Beam Angle

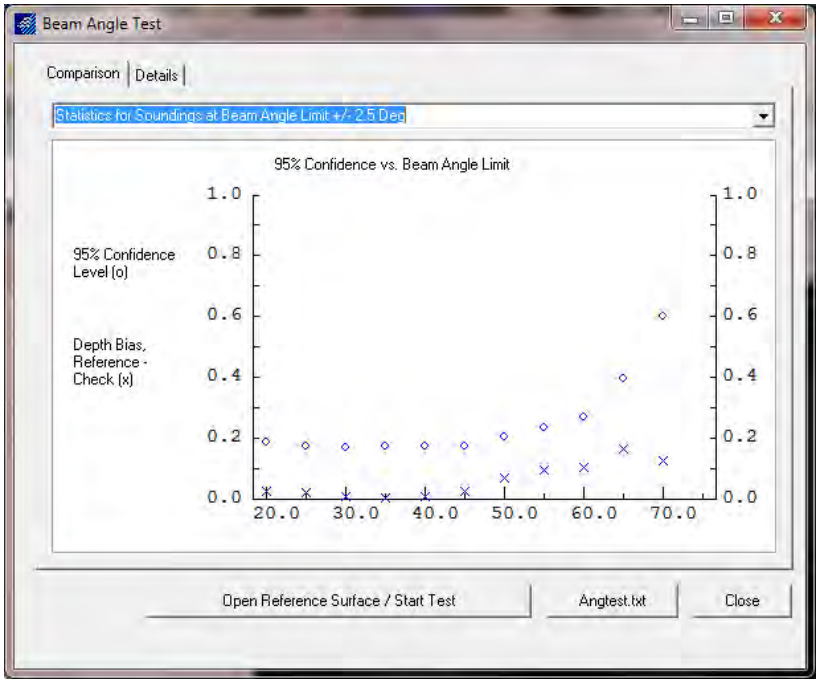


November 10, 2011 Post-Survey Performance Tests

Single beam-Multibeam Performance Test

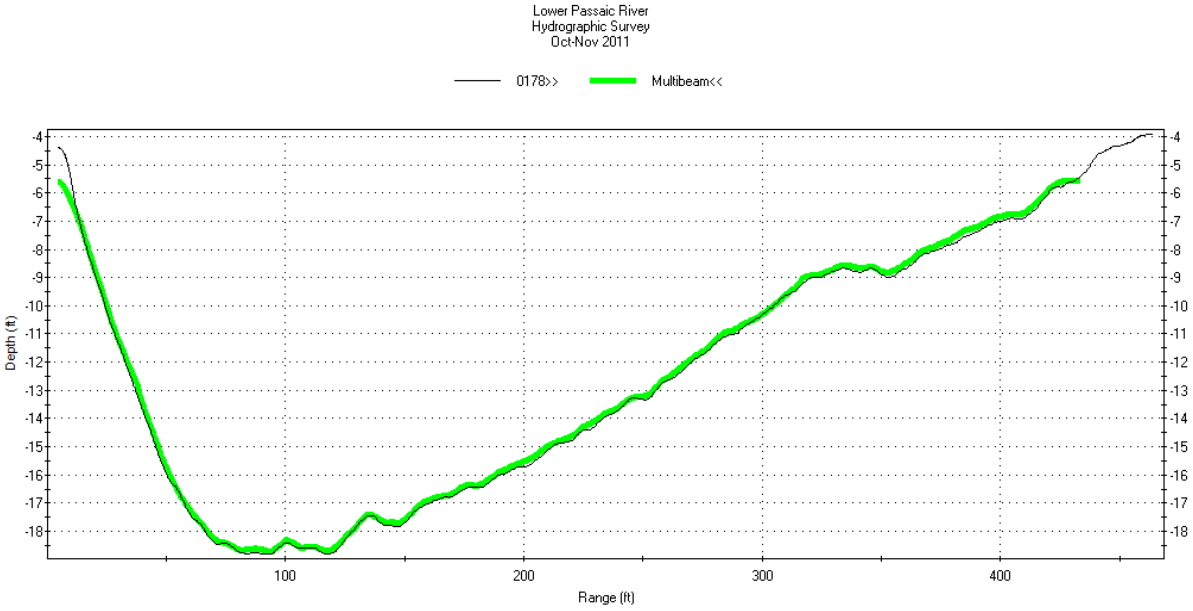


Beam Angle



Single Beam Cross-check Lines

Throughout the course of the survey operations, GBA collected single beam cross-sections as checks to compare against multibeam data. Daily cross check lines were spaced at approximately 500-foot intervals and overlain on the multibeam data. Below is a typical cross-section showing the consistent correlation that exceeds the recommended minimum of 0.5 ft between the survey technologies which adds confidence to the fall 2011 multibeam dataset.



6.0 DAILY OVERVIEW OF SURVEY OPERATIONS

The following information is representative of GBA's daily surveying activities in reference to the multibeam survey of the Passaic River from mile marker 0 to 14.

Tuesday, October 4, 2011

Work performed this day included:

- Mobilization from Baltimore to Newark
- RTK rover check-in to control monuments throughout project site
- Check and set land-based tide staffs for project site

Wednesday, October 5, 2011

Work performed this day included:

- Check and set water-based tide staffs for project site
- Performed patch and performance tests for survey equipment
- Multibeam survey center and edges of Reach B01
- Single beam survey check lines Reach B01

The GBA survey crew was joined by Mr. William Gerkin (AECOM) and Jason Magelan (Sea Engineering, Inc.) as observers.

Thursday, October 6, 2011

Work performed this day included:

- Multibeam survey centers of Reaches B02 through B04
- Single beam survey lines 0148 and 0153 and check lines in Reaches B02 through B04
- Multibeam edges Reach B02 through B03
- Reson multibeam head struck a submerged piling and the mount was damaged

The GBA survey crew was joined by Mr. William Gerkin (AECOM) and Jason Magelan (Sea Engineering, Inc.) as observers.

Friday, October 7, 2011

Work performed this day included:

- Delivered boat to Thomas Marine, Patchogue, New York for repairs
- Demobilization to Baltimore

Saturday, October 22, 2011

The survey crew and vessel remobilized from Baltimore, Maryland to Newark, New Jersey. No survey work was performed this day.

Sunday, October 23, 2011

Work performed this day included:

- Completed the re-start multibeam patch and performance tests
- Multibeam survey centers of Reaches B04 through B06
- Single beam survey lines 0178 and 0192 and check lines for Reaches B04 through B06

The GBA survey crew was joined by Ms. Stephanie Wilson (AECOM) and Jason Magelan (Sea Engineering, Inc.) as observers.

Monday, October 24, 2011

Work performed this day included:

- Multibeam survey edges for Reach B04
- Multibeam survey centers for Reaches B07 through B09
- Multibeam survey under Path and Jackson Street bridges
- Single beam survey line 0204 check lines for Reaches B07 through B09

The GBA survey crew was joined by Ms. Stephanie Wilson (AECOM) and Jason Magelan (Sea Engineering, Inc.) as observers.

Tuesday, October 25, 2011

Work performed this day included:

- Multibeam survey edges for Reaches B05 through B09
- Multibeam survey Reach B01 (check)
- Single beam survey check lines in Reach B01 (check)
- Multibeam survey centers of Reaches E03 and F01
- Single beam survey line 0104 and check lines for Reaches E03 and F01

Wednesday, October 26, 2011

Work performed this day included:

- Multibeam survey Reaches F02 through F04 and G01 through G02
- Multibeam edges for Reaches E03 and F01
- Multibeam center for Reach G03
- Single beam survey check lines for Reaches F02 through G03

Thursday, October 27, 2011

Work performed this day included:

- Multibeam survey edges for Reaches F03 and G03
- Multibeam survey Reaches G04 and H01 through H02
- Single beam survey check lines for Reaches G04 through H02

Friday, October 28, 2011

Work performed this day included:

- Multibeam survey Reaches D01 through D04
- Single beam survey lines 0368 and 0389 and check lines Reaches D01 through D04

Saturday, October 29, 2011

Work performed this day included:

- Multibeam survey edges D01
- Multibeam survey Reaches C09 through C11
- Survey operations suspended due to snow storm

Sunday, October 30, 2011

Work performed this day included:

- Single beam survey check lines for Reaches C09 through C11
- Multibeam survey bridge lines at Reach D01
- Multibeam survey Reaches D05 through D08
- Single beam survey check lines Reaches D05 through D08
- Multibeam survey bridge lines at Reach D05

Monday, October 31, 2011

Work performed this day included:

- Multibeam survey Reaches C05 through C08
- Single beam survey lines 0277 and 0305 and check lines Reaches C05 through C08

Tuesday, November 1, 2011

Work performed this day included:

- Multibeam survey Reaches H03 through H07
- Multibeam survey bridge lines at Reach H07
- Single beam survey check lines for Reaches H03 through H07

Wednesday, November 2, 2011

Work performed this day included:

- Multibeam survey centers of Reaches C03 and C04
- Multibeam survey bridges lines at Reaches C03 and C04
- Single beam survey check lines for Reaches C03 and C04
- Multibeam survey Reaches D09 and E01 through E02
- Single beam survey check lines for Reaches D09 and E01 through E02

Thursday, November 3, 2011

Work performed this day included:

- Multibeam survey Reaches H08 through H11
- Single beam survey check lines for Reaches H08 through H11

Friday, November 4, 2011

Work performed this day included:

- Multibeam survey centers for Reached C01 and C02
- Multibeam survey bridge lines at Reach C02
- Single beam survey line 0235 and check lines for Reaches C01 and C02
- Multibeam survey Reach H12
- Multibeam survey edges for Reaches H08, H09, and H11

Saturday, November 5, 2011

Work performed this day included:

- Mobilization to Newark Bay
- Performed patch and performance tests for survey equipment
- Mobilized to mouth of Passaic River
- Multibeam survey Reach A07

Sunday, November 6, 2011

Work performed this day included:

- Multibeam survey edges for Reaches C03 and C04
- Multibeam survey centers for Reaches A05, A06 and A08
- Single beam survey check lines for Reaches A05 through A08
- Multibeam bridge lines at Reach A08
- Single beam survey lines 0059 and 0078

Monday, November 7, 2011

Work performed this day included:

- Multibeam survey edges at Reach C01and C02
- Multibeam survey bridge lines at Reach A05
- Multibeam survey centers at Reaches A03 through A05

Tuesday, November 8, 2011

Work performed this day included:

- Multibeam survey edges for Reaches A04 through A06 and A08
- Multibeam survey centers for Reaches A01 and A02
- Single beam survey check lines for Reaches A01 through A04

Wednesday, November 9, 2011

Work performed this day included:

- Multibeam survey edges at Reach A03 through A05
- Multibeam survey centers for Reaches A01 and A02

Thursday, November 10, 2011

Work performed this day included:

- Multibeam survey edges for Reaches A01 and A02
- Mobilization to Newark Bay
- Performed patch and performance tests for survey equipment
- Mobilization from Newark to Baltimore

7.0 CONTACT INFORMATION

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Wilmington, DE 19807
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Fax: (302) 655-9218

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Technical Project Manager:
Edward DeAngelo email: edeangelo@gba-inc.com

8.0 REFERENCES

AECOM, 2010. Quality Assurance Project Plan, Lower Passaic River Restoration Project: Periodic Bathymetric Surveys, Revision 2, May.

United States Army Corps of Engineers (USACE). 2002. Engineering and Design Manual - Hydrographic Surveying. EM 1110-2-1003. Washington, D.C. January, augmented April 1, 2004.

APPENDIX 1

Control Information

01392590 A (AI7796)

NGS PID# AI7796
New Jersey Geodetic Survey (NJGS) Cover – stamped 01392590 1997 (steel rod in casing)
New Jersey State Plane NAD 83 Horizontal Coordinates (feet)
Northing 692,097.663 Easting 588,059.003
Vertical Elevation
NAVD 88 = 11.67' NGVD 29 = 12.78'
Situated in the city of Newark, New Jersey, this control point is a steel rod buried in the ground and encased with a lid as stamped above. The marker is located on the east side of Raymond Avenue at the intersection of Van Buren Street. It is measured 32' northeasterly from a light pole and 21' southeasterly from a concrete wall situated on the east side of a concrete walk leading northerly along the exit ramp from Raymond Avenue. Static GPS observations were made from this point to establish horizontal and vertical positioning for the survey project.

CPG

Locally Set Control Point
Triangle carved on top of steel bulkhead
Vertical Elevation (Observed)
NAVD 88 = 8.18’ NGVD 29 = 9.19’

Situated in Wallington, New Jersey, this control point is a triangle chiseled into the top of a steel bulkhead along the east side of the Passaic River. The bulkhead is located on the west side of a parking lot for a business center located on the west side of Madison Street. The mark is measured 17.3’ northerly from a light pole and is adjacent to a floating dock. A closed level loop was run from CPG2, situated just north of this point, where static GPS observations were made.

CPG2

Locally Set Control Point
MAG Nail Set
New Jersey State Plane NAD 83 Horizontal Coordinates (feet)
Northing 733825.441 Easting 597109.293
Vertical Elevation (Observed)
NAVD 88 = 7.936' NGVD 29 = 8.950'

Situated in Wallington, New Jersey, this control point is a MAG Nail set into asphalt near a steel bulkhead along the east side of the Passaic River. The bulkhead is located on the west side of a parking lot for a business center located on the west side of Madison Street. The mark is measured 8.6' northerly from a light pole and is situated along the west side of a guard rail Static GPS observations were made at this point and a closed level loop was run to control point CPG situated just south of this location.

G101

NGS PID# KV3414
National Geodetic Survey (NGS) Disk – stamped G 101 1979
New Jersey State Plane NAD 83 Horizontal Coordinates (feet)
Northing 715490.263 Easting 592312.818
Vertical Elevation
NAVD 88 = 14.24’ NGVD 29 = 15.29’

Situated in North Arlington, New Jersey, this control monument is located along the southeast side of River Road in the front yard of house #352. It is further located 2.0’ southwest of the southwesternmost side of an asphalt driveway leading to house #354. The mark is measured 6.7’ east of utility pole #A60351 NA and 12.2’ northwest of the guy anchor attached to the pole. Static GPS observations were made from this point to establish horizontal and vertical positioning for the survey project.

Nutley

Locally Set Control Point
Mark at edge of Concrete Wall
Vertical Elevation (Observed)
NAVD 88 = 8.73’ NGVD 29 = 9.77’

Situated in Nutley, New Jersey, this control point is a mark chiseled on top of a concrete wall along the eastern edge as it abuts the west side of the Passaic River. The concrete wall is situated along the west side of a parking area for a boat ramp. Boat Ramp is located just north of Park Avenue where it connects with the Kingsland Avenue Bridge leading to the east side of the river. A closed level loop was run from Nutley2, situated south of this point, where static GPS observations were made.

Nutley 2

Locally Set Control Point
Capped Iron Pin Set
New Jersey State Plane NAD 83 Horizontal Coordinates (feet)
Northing 720714.538 Easting 592028.699
Vertical Elevation (Observed)
NAVD 88 = 7.952’ NGVD 29 = 8.992’

Situated in Nutley, New Jersey, this control point is a capped iron pin set in a gravel parking lot and boat ramp situated along the west side of the Passaic River. Boat Ramp is located just north of Park Avenue where it connects to the Kingsland Avenue Bridge leading to the east side of the river. The point is located 3’ westerly from the west edge of a concrete wall along the river and 3’ northwesterly of a concrete curb. Static GPS observations were made at this point and a closed level loop was run to control point Nutley situated just north of this position.

Path

PSE & G Disk – stamped PRO 4 (Passaic River Outfall #4)
New Jersey State Plane NAD 83 Horizontal Coordinates (feet)
Northing 701845.995 Easting 585643.039
Vertical Elevation (Observed)
NAVD 88 = 5.705’ NGVD 29 = 6.791’

Situated in Kearney, New Jersey, this control point is a PSE & G control disk embedded in a concrete flume leading westward from a parking lot into the east side of the Passaic River. The parking lot is situated south of a PathMark grocery store located along the west side of Passaic Avenue. The point is measured 7’0’ northerly from the south edge of the concrete flume and 3.5’ easterly from a guard rail. Static GPS observations were made here and a closed level loop was run to PATH 3 situated north of this position.

Path 3

Locally Set Control Point
Triangle cut chiseled on top of concrete bulkhead
Vertical Elevation (Observed)
NAVD 88 = 6.105’ NGVD 29 = 7.191’

Situated in Kearney, New Jersey, this control point is a triangle cut chiseled into the top of a concrete bulkhead situated along the east side of the Passaic River. The mark is located to the rear of a PathMark grocery store located on the west side of Passaic Avenue and is measured 35’ northeasterly of a large cleat and 20’ southwesterly of another large cleat. It is further measured 14.5’ northwesterly of the westernmost corner of a storm drain.

PORT 1 & 2

Locally Set Control Point

Sheared Metal Bolt
New Jersey State Plane NAD 83 Horizontal Coordinates (feet)
Northing 695188.398 Easting 597847.469
Vertical Elevation (Observed)
Port 1 NAVD 88 = 8.96' NGVD 29 = 10.08'
Port 2 NAVD 88 = 8.89' NGVD 29 = 10.01'

Situated near Kearney, New Jersey, this control point is a sheared metal bolt located on a concrete dauphin situated in the Passaic River west of a New York-New Jersey Shipping Authority facility located at the westernmost end of Pennsylvania Avenue. It is measured 6.6' northeast of the southwest side of the dauphin. It is further measured 5.3 feet northwest of the southeast side of the dauphin. Static GPD observations were made here and a closed level loop was run to **PORT 2** situated along the southeastern-most edge of the dauphin.

NJIT/NJI2

NJIT

SEARCH NCE GO MY NJIT

NCE
CIVIL AND ENVIRONMENTAL ENGINEERING

Engineers : The Creative Problem-Solvers

About CEE
- Mission
- Program Objectives & Outcomes
- Key Contacts
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- Laboratories
- Program Self Study Report

Academic Programs
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Surveying GPS Laboratory

Continuously Operating Base Station at NJIT

The GPS base station was established thanks to grants from the New Jersye Society of Professional Land Surveyors and Leica.

IMPORTANT ANNOUNCEMENT:

NGS has renamed the basestation, now that it has a new position. It is now posted as **nji2**.

The following coordinates reflect the relocated basestation, as of June 11, 2001.

SITE:	OPTION:	DATE:
NH Portsmouth , por1	RINEX2 Data	98271 - Sep. 28
NH Portsmouth , por2	Readme.doy	98272 - Sep. 29
NJ Newark , njit	Coordinates (NAD83 & ITRF94)	98273 - Sep. 30
NJ Sandy_Hook , shk1	Coordinates (NAD83 & ITRF96)	98274 - Oct. 1,
NJ Sandy_Hook , shk2	Logfile	98275 - Oct. 2,
NM Pie_Town , pie1	Broadcast Ephemeris	98276 - Oct. 3,

Find_Files | Reset

Latitide: 40 degrees 44' 29.30562" N
Longitude: 74 degrees 10' 39.72764" W

http://civil.njit.edu/about/labs/surveying.php 11/8/2007

The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

```
DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 7.55
1        National Geodetic Survey,   Retrieval Date = NOVEMBER  8, 2007
 AJ3348 ***********************************************************************
 AJ3348  HT_MOD      -  This is a Height Modernization Survey Station.
 AJ3348  CORS        -  This is a GPS Continuously Operating Reference Station.
 AJ3348  DESIGNATION -  NJ INST OF TECH 2 CORS ARP
 AJ3348  CORS_ID     -  NJI2
 AJ3348  PID         -  AJ3348
 AJ3348  STATE/COUNTY-  NJ/ESSEX
 AJ3348  USGS QUAD   -  ELIZABETH (1995)
 AJ3348
 AJ3348                        *CURRENT SURVEY CONTROL
 AJ3348  ______________________________________________________________________
 AJ3348* NAD 83(CORS)-  40 44 29.30573(N)     074 10 39.72731(W)      ADJUSTED
 AJ3348* NAVD 88     -        50.24   (meters)      164.8    (feet)   GPS OBS
 AJ3348  ______________________________________________________________________
 AJ3348  EPOCH DATE  -        2002.00
 AJ3348  X           -  1,319,482.656 (meters)                        COMP
 AJ3348  Y           - -4,656,035.856 (meters)                        COMP
 AJ3348  Z           -  4,140,724.998 (meters)                        COMP
 AJ3348  ELLIP HEIGHT-          17.929 (meters)           (03/??/02) ADJUSTED
 AJ3348  GEOID HEIGHT-         -32.30  (meters)                        GEOID03
 AJ3348  HORZ ORDER  -  SPECIAL (CORS)
 AJ3348  ELLP ORDER  -  SPECIAL (CORS)
 AJ3348
 AJ3348.ITRF positions are available for this station.
 AJ3348.The coordinates were established by GPS observations
 AJ3348.and adjusted by the National Geodetic Survey in March 2002.
 AJ3348.The coordinates are valid at the epoch date displayed above.
 AJ3348.The epoch date for horizontal control is a decimal equivalence
 AJ3348.of Year/Month/Day.
 AJ3348
 AJ3348.The orthometric height was determined by GPS observations and a
 AJ3348.high-resolution geoid model using precise GPS observation and
 AJ3348.processing techniques.
 AJ3348
 AJ3348.The PID for the CORS L1 Phase Center is AJ7974.
 AJ3348
 AJ3348.The XYZ, and position/ellipsoidal ht. are equivalent.
 AJ3348
 AJ3348.The ellipsoidal height was determined by GPS observations
 AJ3348.and is referenced to NAD 83.
 AJ3348
 AJ3348.The geoid height was determined by GEOID03.
 AJ3348
 AJ3348;                  North         East      Units Scale Factor Converg.
 AJ3348;SPC NJ       -   211,890.703   177,219.575   MT  0.99990912   +0 12 37.3
 AJ3348;SPC NJ       -   695,178.08    581,427.89    sFT 0.99990912   +0 12 37.3
 AJ3348
 AJ3348!             -  Elev Factor  x  Scale Factor =   Combined Factor
 AJ3348!SPC NJ       -   0.99999719  x   0.99990912  =   0.99990631
 AJ3348
 AJ3348                           SUPERSEDED SURVEY CONTROL
 AJ3348
 AJ3348  NAD 83(CORS)-  40 44 29.30562(N)     074 10 39.72764(W) AD(1997.00) c
 AJ3348  ELLIP H (06/??/01)   17.928  (m)                        GP(1997.00) c c
 AJ3348
 AJ3348.Superseded values are not recommended for survey control.
```

```
AJ3348.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
AJ3348.See file dsdata.txt to determine how the superseded data were derived.
AJ3348
AJ3348_U.S. NATIONAL GRID SPATIAL ADDRESS: 18TWL6942610384(NAD 83)
AJ3348_MARKER: STATION IS THE ANTENNA REFERENCE POINT OF THE GPS ANTENNA
AJ3348
AJ3348                          STATION DESCRIPTION
AJ3348
AJ3348'DESCRIBED BY NATIONAL GEODETIC SURVEY 2002
AJ3348'STATION IS A GPS CORS.  LATEST INFORMATION INCLUDING POSITIONS AND
AJ3348'VELOCITIES ARE AVAILABLE IN THE COORDINATE AND LOG FILES ACCESSIBLE
AJ3348'BY ANONYMOUS FTP OR THE WORLDWIDE WEB.
AJ3348'    FTP CORS.NGS.NOAA.GOV: CORS/COORD  AND  CORS/STATION_LOG
AJ3348'    HTTP://WWW.NGS.NOAA.GOV  UNDER PRODUCTS AND SERVICES.

*** retrieval complete.
Elapsed Time = 00:00:00
```

APPENDIX 2

0.5 ft Contour Plots of Multibeam Data

APPENDIX 3

Single Beam Cross Sections

APPENDIX 4

Copy of Field Notes

APPENDIX 5

Portable Disk including:

Survey Report,
AutoCAD Drawings,
HYPACK Files,
Field Notes,
ASCII Data

Attachment 2

Periodic Bathymetry Survey, Fall 2011 Post Hurricane Irene Survey Oversight Report

Prepared for:
Cooperating Parties Group
New Jersey

Prepared by:
AECOM
Seattle, WA
60145884.P221
March 2012

Periodic Bathymetry Survey, Fall 2011 Post Hurricane Irene Survey Oversight Report

LOWER PASSAIC RIVER, New Jersey

October 5, 2011 – November 10, 2011

Prepared by: William Gerken
AECOM
710 Second Ave, Suite 1000
Seattle, WA 98104

Reviewed by: Douglas E. Simmons
AECOM
250 Apollo Drive
Chelmsford, MA 01824

Contents

List of Appendices

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PERIODIC BATHYMETRY SURVEY
FALL 2011 POST HURRICANE IRENE SURVEY
OVERSIGHT REPORT
October 5, 2011 – November 10, 2011

1.0 Project

Lower Passaic River Restoration Project, Periodic Bathymetric Surveys, AECOM Environment, Project Number 60145884.P221.

2.0 Purpose

The Fall 2011 Post Hurricane Irene Bathymetry Survey (Fall 2011 Survey) was conducted by AECOM's contractor, Gahagan & Bryant Associates, Inc. (GBA) between October 5, 2011 and November 10, 2011, with mobilization to the Lower Passaic River Study Area (LPRSA) and checking of control points on October 4, 2011. The survey was suspended on October 6, 2011 due to damage incurred by the survey equipment and restarted on October 23, 2011 once the equipment was repaired. The multibeam survey extended from river mile (RM) 0 to RM 14 of the Lower Passaic River (LPR) covering the same basic area as the 2007, 2008, and 2010 bathymetry surveys. A summer 2011 bathymetry survey was conducted of the RM 10.9 Study Area. A single beam survey was conducted of thirteen selected transects, surveyed previously during the fall 2008 and spring 2010 survey events. These transects extended from RM 1.6 to RM 8.0.

Oversight of the survey was provided by AECOM technical staff, and included both on-site observations at selected intervals (during four days) and daily off-site review of calibration records, survey logs, coverage maps, and progress e-mails. Bill Gerken of AECOM performed primary oversight of the Fall 2011 Survey. He was on site to observe the survey for two days at the beginning of the survey and performed off site oversight activities for the remainder of the survey period. Stephanie Wilson of AECOM was on site to observe the survey for two days following the restart of the survey. Oversight included review of equipment set up and calibration for consistency with USACE's Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003 (USACE, 2002) as well as consistency with previous (2007, 2008, 2010, and summer 2011) surveys and conformance with the Quality Assurance Project Plan (QAPP) for the Lower Passaic River Restoration Project: Periodic Bathymetric Surveys, Revision 2 (AECOM, 2010); hereafter referred to as the QAPP. Sea Engineering, Inc. provided oversight on behalf of the United States Environmental Protection Agency (USEPA).

This report (Attachment 2 to the Periodic Bathymetry Survey Report, Fall 2011 Post Hurricane Irene Survey) provides details of the bathymetry oversight activities only. GBA's report (Attachment 1 to the Periodic Bathymetry Survey Report, Fall 2011 Post Hurricane Irene Survey) provides details of the bathymetry survey. Processed data files were provided to USEPA under separate cover.

3.0 Survey Location

The multibeam survey extended from RM 0 to RM 14 of the LPR covering the same basic area as the 2007, 2008, and 2010 bathymetry surveys. A single beam survey was conducted of thirteen selected transects, surveyed previously during the fall 2008 and spring 2010 survey events. These transects extended from RM 1.6 to RM 8.0.

All patch and performance tests were conducted at the same approximate locations as for the previous bathymetry surveys and are described in Section 5.

4.0 GBA Personnel, Equipment and Software

The GBA team consisted of a Lead Project Surveyor and a two-person crew and included individuals (including the technical lead) that had supported prior LPRSA surveys. The 25-foot GBA survey vessel *Sea Fix* was used for the Fall 2011 Survey. The equipment used aboard the *Sea Fix*, including equipment for patch and performance tests, and survey operations, was the same as that used during the summer 2011 bathymetry survey by GBA. The equipment on the *Sea Fix* included the Reson 8101 multibeam echosounder, Odem Mark III depth recorder, Trimble Real Time Kinematic (RTK) positioning system, Applanix-TSS POS-MV and HYPACK/HYSWEEP data collection/processing software. In addition, an Applied Microsystems velocity probe was used for sound velocity measurements and a disc type aluminum plate was used for bar check calibrations.

5.0 Process

The survey vessel was mobilized to New Jersey on October 4, 2011. The survey was conducted from October 5, 2011 through November 10, 2011. The survey was suspended on October 6, 2011 due to damage incurred by the survey equipment and restarted on October 23, 2011 once the equipment was repaired. Figures depicting the reaches described in this section are provided in GBA's report (Attachment 2 to the Periodic Bathymetry Survey Report, Fall 2011 Post Hurricane Irene Survey). GBA's report also includes survey logs and screen images of patch and performance tests.

Oversight included on-site and off-site activities to ensure compliance with the required quality and performance standards identified in the QAPP (AECOM, 2010). These performance criteria include maximum allowable bias as per the USACE's Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003, Chapter 3, Table 3.1 (USACE, 2002). Sea Engineering, Inc. provided oversight on behalf of the USEPA.

All work was performed per the QAPP, contract requirements, USACE specifications and acceptable industry standards.

5.1 On-Site Observations

The following four sections describe the oversight activities conducted while AECOM staff were on site to observe the survey activities. Oversight activities included on-site observations at selected intervals (during 4 days) and daily off-site review of calibration records, survey logs, coverage maps, and progress e-mails between GBA and AECOM staff. AECOM staff were on site over 4 days, as described below. AECOM field notes are provided in Appendix A. Off-site oversight activities are described in Section 5.2.

5.1.1 October 5, 2011

Weather conditions: mostly sunny, approximately 65° Fahrenheit (F), light wind, and calm seas.

The *Sea Fix* departed from the Elizabeth City Marina and headed for the Newark Bay patch and performance test area, stopping at the Port Elizabeth dock to perform a velocity cast/check and bar check. On the vessel were Bill Gerken (AECOM), Ed DeAngelo (GBA), Bill Carroll (GBA), and Jason Magalen (Sea Engineering, Inc.). A multibeam system patch test was performed on the *Sea Fix* in Newark Bay. This test consisted of a series of survey lines run to reveal and then correct for any system biases in roll, pitch, and yaw.

A performance test (beam angle test and single beam-multibeam comparison test) was conducted in Newark Bay. Separate multibeam and single beam surveys were run and the overlapping data were compared to evaluate the multibeam data quality. This check provided a statistical estimate of the data accuracy. The quality control calibration and performance test were processed and adjusted

aboard the survey vessel prior to any multibeam data collection. After the performance test, the *Sea Fix* proceeded to PORT 2 at RM 2.2 where the crew set a new tide staff and verified vertical control.

The survey vessel then proceeded to the RM 2.5 Reach B01 survey area. Multibeam survey and single beam check lines were completed for Reach B01. Single beam data were collected at Line 104, which is one the 13 designated Single beam transects. Sound velocity casts, bar checks, and tide checks were performed.

5.1.2 October 6, 2011

Weather conditions: mostly sunny, approximately 60° F, light wind, and calm seas.

After checking the tide at PORT 2, the *Sea Fix* proceeded to the Reach B02 (at approximately RM 2.7) survey area to begin multibeam survey work. On the vessel were Bill Gerken (AECOM), Ed DeAngelo (GBA), Bill Carroll (GBA), Travis Schmidt (GBA), and Jason Magalen (Sea Engineering, Inc.). A multibeam survey was undertaken in center portions of Reaches B02 through B04 and along the edges of Reaches B02 and B03. The multibeam survey along shoreline edges can only be accomplished during high tide. Single beam check lines were run for Reaches B02 through B04. Velocity casts, bar checks, and tide checks were performed.

The multibeam transducer head hit an obstruction in the shallow water portion of Reach B03 and the mounting arm broke free from the survey vessel. The head and arm were retrieved. The head appeared intact and undamaged but the mounting arm incurred damage. The *Sea Fix* headed back to the marina following a tide check. Due to the damage to the mounting arm, the survey was suspended and restarted on October 23, 2011.

5.1.3 October 23, 2011

Weather conditions: mostly cloudy, approximately 55° F, light wind, and calm seas.

The *Sea Fix* departed the Elizabeth City Marina and headed for Newark Bay for patch and performance tests, stopping at the Port Elizabeth dock to perform a velocity cast/check and bar check. On the vessel were Stephanie Wilson (AECOM), Ed DeAngelo (GBA), Bill Carroll (GBA), Travis Schmidt (GBA), and Jason Magalen (Sea Engineering, Inc.). A multibeam system patch test was performed on the *Sea Fix* in Newark Bay. This test consisted of a series of survey lines run to reveal and then correct for any system biases in roll, pitch, and yaw.

A performance test (beam angle test and single beam-multibeam comparison test) was conducted in Newark Bay. Separate multibeam and single beam surveys were run and the overlapping data were compared to evaluate the multibeam data quality. This check provided a statistical estimate of the data accuracy. The quality control calibration and performance test were processed and adjusted aboard the survey vessel prior to any multibeam data collection. After the performance test, the *Sea Fix* proceeded to PORT 2 at RM 2.2 to check the tide board and verify vertical control.

The survey vessel then proceeded to the Reach B04 survey area to begin multibeam survey work. A multibeam survey was undertaken in the center portions of Reaches B04 through B06. Single beam check lines were completed for Reaches B04 through B06.

5.1.4 October 24, 2011

Weather conditions: partly cloudy, approximately 55° F, light wind, and calm seas.

After checking the tide at PORT 2, the *Sea Fix* proceeded to the Reach B04 survey area to begin the multibeam survey work in the shallow water edges of this reach during the higher morning tides. On the vessel were Stephanie Wilson (AECOM), Ed DeAngelo (GBA), Bill Carroll (GBA), Travis Schmidt

(GBA), and Jason Magalen (Sea Engineering, Inc.). Work was stopped in Reach B04 due to the tide level and the *Sea Fix* was moved to the center portion of Reach B07. A multibeam survey was completed in the center portions of Reaches B07 through B09. Multibeam survey fill-in work was completed around the Path and Jackson Street bridges in Reach B06. Single beam check lines were run for Reaches B07 through B09. Sound velocity casts, bar checks, and tide checks were performed. The *Sea Fix* headed back to marina following a tide check.

5.2 Off-Site Oversight Activities

For all survey days where AECOM staff were not on site, Bill Gerken of AECOM was available by phone and e-mail to address questions and/or concerns. Each day, he received daily field logs, coverage maps, e-mail progress updates, and any additional tests or QA/QC data for review. Bill Gerken reviewed this information daily to ensure the survey was meeting the requirements set forth in the QAPP. Copies of these records are on file at AECOM. The only deviations from the QAPP were minor and are described below.

6.0 Deviations from the QAPP

The following represent minor deviations from the QAPP (AECOM, 2010). However, these deviations did not impact achievement of the data quality objectives developed for this bathymetry survey.

- October 6, 2011 – An area approximately 120 feet by 550 feet was not surveyed because of obstructions related to the Phase 1 Removal Action at the Lister Avenue Site.
- October 27, 2011 – There were several areas along the shore where GBA was not able to achieve the (-)6-foot contour because of trees overhanging the river, and large rocks along the shoreline. Construction around the Route 3 bridge located at RM 11.6 reduced coverage compared to historical surveys as well.
- October 31, 2011 through November 4, 2011 – High tides peaked at lower levels during this week ([+]4 feet National Geodetic Vertical Datum of 1929 [NGVD29] as opposed to [+]6 feet NGVD29 during the prior week). The lower high tides along with overhanging trees limited access to complete the (-)6-foot contour.

7.0 Results

All calibration data collected were in conformance with criteria specified in the QAPP (AECOM, 2010). The results of the pre-survey, re-start of survey, mid-survey, and post-survey performance tests are given below in Table 1; all results are consistent with the USACE's Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003 (USACE, 2002). The maximum allowable bias (mean difference) is a measure of the difference between the multibeam survey and the single beam survey run over the same location. Single beam check lines performed daily validated accuracy/repeatability of the multibeam work completed. The pre-survey, re-start of survey, mid-survey, and post-survey results compare favorably with applicable soft bottom standards presented in the USACE's Engineering and Design Manual - Hydrographic Surveying, EM 1110-2-1003 (USACE, 2002).

Table 2 Minimum Quality and Performance Standards for Hydrographic Surveys

	Standards[1]	Pre-Survey Results (October 5, 2011)	Re-Start of Survey Results (October 23, 2011)	Mid-Survey Results (November 5, 2011)	Post-Survey Results (November 10, 2011)
Maximum outliers between data set comparison points	1 ft	0.78 ft	0.51 ft	0.81 ft	0.62 ft
Maximum allowable bias	± 0.2 ft	- 0.05 ft	0.07 ft	0.13 ft	0.03 ft
Resultant elevation/depth accuracy (95%) (acoustic survey at depth > 40 ft)	± 2.0 ft	0.41 ft	0.16 ft	0.26 ft	0.28 ft

[1] Navigation & Dredging Surveys Bottom Material Classification - Soft (from USACE's Engineering and Design - Hydrographic Surveying, EM 1110-2-1003, Chapter 3, Table 3.1 and Chapter 11, Table 11.2 [USACE, 2002])

Horizontal position checks were performed at the dock at the beginning and end of each day to reveal any potential positioning errors. The differences in position were within industry standards and contract specifications.

Single beam bar checks were performed within the project area as a method of calibration for acoustic depth measurements and adjustments that needed to be made to subsequent recorded depths. Bar checks were performed, at a minimum, before and after each single beam survey event, checks were made at multiple depth intervals. A multibeam bar check was conducted in Baltimore, MD prior to mobilizing and again when the vessel was on site in New Jersey.

Sound velocity profiles were also collected using a velocity probe to measure changes in the water column that affect data quality such as temperature and salinity. Velocity profiles were taken in the work area at the beginning of data collection on each reach and/or sub-reach, and the start of each day. This resulted in multiple velocity profiles being collected each day.

8.0 Conclusion

The survey equipment and calibration and survey procedures used by GBA during the Fall 2011 Post Hurricane Irene Survey conform to the applicable accuracy standards and quality control and quality assurance requirements specified in the QAPP, contract requirements, USACE specifications, and acceptable industry standards.

9.0 Contact

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10.0 References

AECOM, 2010. Quality Assurance Project Plan, Lower Passaic River Restoration Project: Periodic Bathymetric Surveys, Revision 2, May.

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Appendix A

AECOM Field Notes